Report on

Open RDA – RVP8 Data Quality Using Meteorological Data:

Engineering Analysis, Base Data Analysis, and Algorithm Analysis

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Executive Summary

This report evaluates the SIGMET RVP8 Processor and GMAP clutter filter using meteorological data. The evaluation took place between March 2004 and July 2004 and was conducted in three phases. Phase I uses actual weather data and validated an earlier engineering study, documented in a report entitled "Report on Open RDA – RVP8 Signal Processing Part 1 – Simulation Study Including Gaussian Model Adaptive Processing (GMAP) Clutter Filter Evaluation". Phase II evaluates suitability of base data, including clutter filtering, for field forecaster use. Phase III compares meteorological algorithm output with algorithm output using legacy signal processing.

Operating on real data, the GMAP clutter filter algorithm meets System Specification (NTR) requirement for: 1) clutter suppression levels of 50 dB; 2) velocity bias contribution by the clutter suppression device of less than 2 ms^{-1}; 3) velocity standard deviation of less than 2 ms^{-1} by the clutter suppression device; and 4) reflectivity bias if subject to the spectrum width, minimum usable velocity, and test criteria of the NTR.

The base data evaluation team identified numerous data quality issues with ORDA reflectivity, velocity, and spectrum width products. Interaction between base data evaluation team members and ORDA engineers proved valuable in identifying system problems. Data quality is improving as ROC ENG / ORDA team engineers installed the 72 MHz IFD and corrected software problems.

This report is an interim report because of delays collecting acceptable real-time data for completing the base data and algorithm evaluations, Phase II and Phase III, respectively. The base data evaluation is partially complete and the algorithm evaluation has not begun. Also, the Porta-ORDA field test, Phase IV, is scheduled for October – November 2004. A final report will be delivered after results from the Porta-ORDA field test have been documented and the algorithm evaluation has been completed.

Background

The WSR-88D Radar Operations Center (ROC) has evaluated the new signal processor, digital receiver, and software algorithms under development by the National Weather Service (NWS) Office of Science and Technology (OST), Open Radar Data Acquisition (ORDA) project. The first report, Report on Open RDA - RVP8 Signal Processing Part 1: Simulation Study, focused on performance of the basic moment estimators and the Gaussian Model Adaptive Processing (GMAP) clutter filter by SIGMET. The engineering evaluation team concluded that the RVP8 reflectivity, velocity and R1/R2 spectrum width moment estimators meet WSR-88D performance requirements. The noise compensated R0/R1 spectrum width estimator also meets requirements. The team also concluded that GMAP clutter management techniques meet WSR-88D requirements.

Overview

The IV&V objectives of this report are to:

1. Confirm previous results obtained by the engineering study that used simulated data. Comparisons were performed using historical and newly-collected level 1 data.

2. Evaluate base data; reflectivity, velocity, spectrum width; generated with a SIGMET RVP8 processor with and without the GMAP clutter filter. Meteorological usefulness of the base data was assessed. Comparisons were performed using newly-collected level I data and newly-collected level II data.

3. Compare algorithm output generated by the SIGMET RVP8 processor with algorithm output generated by the legacy WSR-88D signal processor. The comparisons were performed from a meteorological perspective under various meteorological conditions to assess usability by NWS, DOD, and DOT meteorologists. Comparisons were performed using newly-collected level II data.

ROC Applications Branch managed the project, evaluated algorithm output, collected and archived KJIM & KTLX data, and produced the final report. RSIS personnel were responsible for identifying level I data sets and checking for obvious bias and estimator variance with and with out the clutter filter. Personnel from ROC Operations Branch and Warning Decision Training Branch assisted in evaluating meteorological quality of the base products. Members of the RSIS/ORDA team and ROC Engineering personnel were responsible for collecting real-time ORDA data for use in base product and algorithm evaluations.

Phase 1: Engineering Study

The accompanying report entitled "Report on Open RDA – RVP8 Signal Processing Part 2: Engineering Analysis with Meteorological Data Gaussian Model Adaptive Processing (GMAP) Clutter Filter Evaluation" documents the engineering study, Phase I, of the data quality investigations.

Phase II: Base Data Evaluation

The accompanying report entitled "Report on Open RDA – RVP8 Data Quality Using Meteorological Data: Base Data Analysis" documents the base data evaluation, Phase II, of the data quality investigations. This reports describes data quality evaluations and product comparisons between ORDA and legacy systems. The report is not complete as of August 2004.

Phase III: Algorithm Evaluation

The algorithm evaluation has not begun as of August 2004. Evaluation results will be reported in December assuming that sufficient quality data can be collected in the fall of 2004.

Phase IV: Porta-ORDA Field Test

The Porta-ORDA field test will be conducted under the window of Build 7 System Test. Corpus Christy, Texas and Pueblo, Colorado will serve as test sites. The Porta-ORDA system is scheduled to be at Corpus Christy in October 2004 and at Pueblo in November 2004. Data collection efforts will concentrate on sea clutter, mountain clutter, strong clutter at long range from the radar, and a winter case with few reflectors. Field test results will be reported in December assuming that the field test is a success.

Summary

Operating on real data, the GMAP clutter filter algorithm exhibits the following performance:

- Meets and slightly exceeds the System Specification (NTR) requirement for clutter suppression levels of 50 dB

- Meets the System Specification (NTR) requirement for velocity bias contribution by the clutter suppression device of less than 2 ms^{-1}

- Meets the System Specification (NTR) requirement for velocity standard deviation of less than 2 ms^{-1} by the clutter suppression device

- Increases the standard deviation of the reflectivity estimate

- Meets the System Specification (NTR) for reflectivity bias if subject to the spectrum width, minimum usable velocity, and test criteria of the NTR

GMAP does not meet the post correction reflectivity bias goal of less than 2 dB. (This is not a System Specification Requirement but a goal of the reflectivity bias post correction scheme for hydrology products.) Bias values occur within a narrow region of mean velocities, typically between + and – 1 to 2 ms-1, and are also typically less than that imposed by the legacy filters.

GMAP Performance is not very sensitive to the GMAP seed value for clutter spectrum width as expected from the simulation study. In fact, analysis with real data shows virtually no dependency on the seed width values.

The SIGMET / GMAP base data evaluation team identified numerous data quality issues with the ORDA system. Interaction between base data evaluation team members and ORDA engineers proved valuable in identifying system problems. ORDA/RSIS team members are working on remaining problems that are expected to be implemented no later than August 19. SIGMET/GMAP Evaluation team will continue their Base Data evaluation as part of the ORDA System Test, which is scheduled to begin in mid-August and continue until late-November.

The algorithm evaluation, Phase III, and Porta-ORDA field test, Phase IV, have not been completed. These last two phases of the SIGMET / GMAP evaluation project will be completed in December, assuming that adequate radar data is collected for the algorithm evaluation and that the Porta-ORDA field test is successful.